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A new species of scale-worm (Polychaeta: Polynoidae) from Axial Volcano, Juan de Fuca Ridge, northeast Pacific

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Abstract.—*Vampiropolynoe embleyi,* a new genus and species of scale-worm (Polychaeta: Polynoidae), is described from hydrothermal vents created by the 1998 eruption of Axial Volcano (Juan de Fuca Ridge, NE Pacific). Based on this species we propose a new subfamily, the Vampiropolynoinae. This subfamily is closely related to the deep-sea subfamilies Macellicephalinae and Lepidonotopodinae. However, the Vampiropolynoinae differs by having a significantly greater number of segments, by lacking jaws, and by possessing a pair of strong curved acicular lobes on the tentacular segment. The mouth structure, along with sea-floor observations, suggests that *V. embleyi* grazes on bacterial mats. We propose that *V. embleyi* is a pioneer species adapted to living at new vents.

Axial Volcano (Juan de Fuca Ridge) erupted in January 1998, initiating new venting along a lava flow over 3 km long (Embley & Baker 1999). Observations seven months after the eruption with the remotely operated vehicle ROPOS revealed new vents already colonized by numerous vent species (Tsurumi et al. 1998). Common Axial Volcano polynoids (*Branchinotogluma* spp., *Opisthotrochopodus tunnicliffeae, Lepidonotopodium piscesae*) were present in high numbers at most new vents (Marcus, pers. obs.). Along with these typical vent polynoids, an unknown large bright red scale-worm was observed in high densities, feeding on the bacteria-covered basalt of vent peripheries. Here we describe this new species from collections made in the summers of 1998, 1999 and 2000.

There are nine subfamilies of polynoid polychaetes known from hydrothermal vents (Tunnicliffe et al. 1998). Of these, four are known from the Juan de Fuca Ridge. We argue that the new species described herein is distinct enough from vent and other deep-sea subfamilies to warrant the formation of a new subfamily allied to the Macellicephalinae Hartmann-Schröder, 1971, emended Pettibone, 1976 and the Lepidonotopodinae Pettibone, 1983.

Materials and Methods

Type locality.—Axial Volcano, Juan de Fuca Ridge, 45°56′N, 128°59′W, 1530 m depth ("South Rift Zone" venting area). Specimens were suctioned from bare basalt on vent peripheries.

Type material.—Holotype (dive R488, 27 Jun 1999; USNM 1002015) and 2 paratypes (dive R473; USNM 1002016) are deposited in the collections of the National Museum of Natural History, Smithsonian Institution, Washington, D.C. Another paratype is deposited in the collections of the Canadian Museum of Nature, Ottawa, Ontario (dive R474; CMNA 2001-0001).

Additional Material.—A total of 23 specimens were collected during ROPOS dives R462 (1 specimen, Marker 33 site), R473

(17 specimens, Marker 108 and Marker 33 sites), R474 (1 specimen, Milky site), R488 (2 specimens, Cloud site), R543 (1 specimen, Marker N41 site), R549 (1 specimen, Cloud site). Four specimens from R473 were deep-frozen for isotope analysis, and 1 specimen from R543 was preserved in ethanol for DNA analysis.

Specimen preparation.—Two specimens, fixed with 7% seawater formalin and preserved in 70% ethanol, were prepared for scanning electron microscopy (SEM). They were critical point dried with carbon dioxide, sputtered with gold and examined with a Jeol scanning electron microscope (JSM-5200).

Systematics

Family Polynoidae
Vampiropolynoinae, new subfamily

Diagnosis.—Polynoid with elongated body, up to 45 segments. Elytra 10 pairs, on segments 2, 4, 5, 7, 9 alternating to 19. Dorsal cirri on non-elytrigerous segments. Prostomium bilobed. Lateral antennae absent. Median antenna inserted in central notch of prostomium. Frontal filaments hooked. First segment fused to prostomium; a pair of strong, prominent acicular lobes curve toward midline of the body. Eyes lacking. Jaws absent. Keratinized teeth cover junction between mouth opening and pharynx. Curved conical papillae on the upper, lateral, and ventral lips surround mouth opening. Parapodia biramous. Digitiform dorsal tubercles present on all cirrigerous segments, starting on segment 6; absent from elytrigerous segments. Ventral nephridial papillae indistinct. Pygidium with a pair of anal cirri.

This subfamily comprises a single species described in this paper.

Vampiropolynoe, new genus

Diagnosis.—Characters of the subfamily.

Type species.—*Vampiropolynoe embleyi,* new species, by present designation.

Gender.—Feminine.

Etymology.—*Vampiro* is from the English vampire, in reference to the fang-like appearance of the acicular lobes on the first segment and papillae at the mouth, and *polynoe* is taken from the family name Polynoidae.

Vampiropolynoe embleyi, new species
Figs. 1–5

Diagnosis.—Characters of the subfamily.

Etymology.—The species is named after Robert Embley, chief scientist of the 1998–2000 Axial cruises when specimens of this new species were collected.

Description.—Preserved holotype 46 mm long for 45 segments, 12 mm wide including parapodia (excluding setae), and 3 mm wide without parapodia. Largest paratype 52 mm long for 43 segments; smallest paratype 36 mm long for 44 segments. Body long, tapers gently posteriorly (Fig. 1A). Living specimens bright red, with white setae, and reaching live lengths up to 55 mm. After preservation, specimens light brown.

Elytra 10 pairs on segments 2, 4, 5, 7, 9 alternating to 19. First pair of elytra overlap medially but leave a central notch through which the median antenna protrudes. Elytra overlap anteriorly and posteriorly, but leave a gap along the mid-dorsal line. Elytra attach eccentrically on prominent elytrophores. Elytra translucent, smooth, oval, and without ornamentation (Fig. 1B). Elytral surface covered by numerous small circular pits about 5–10 μm in diameter (Fig. 1C).

Dorsal cirri with cylindrical cirrophores attached dorso-posteriorly on the notopodia (Fig. 1D). Cirri extremely long (up to half the length of the worm), and taper gradually to tips. Lines of cilia on parapodia, except on ventral side (Figs. 1D, 4A–D, 5E). No transverse lines of cilia on the middorsum (Fig. 1D). Digitiform dorsal tubercles on all cirrigerous segments (Figs. 1A, D, E, 4C–F), starting on segment 6 (Fig. 1E). Dorsal

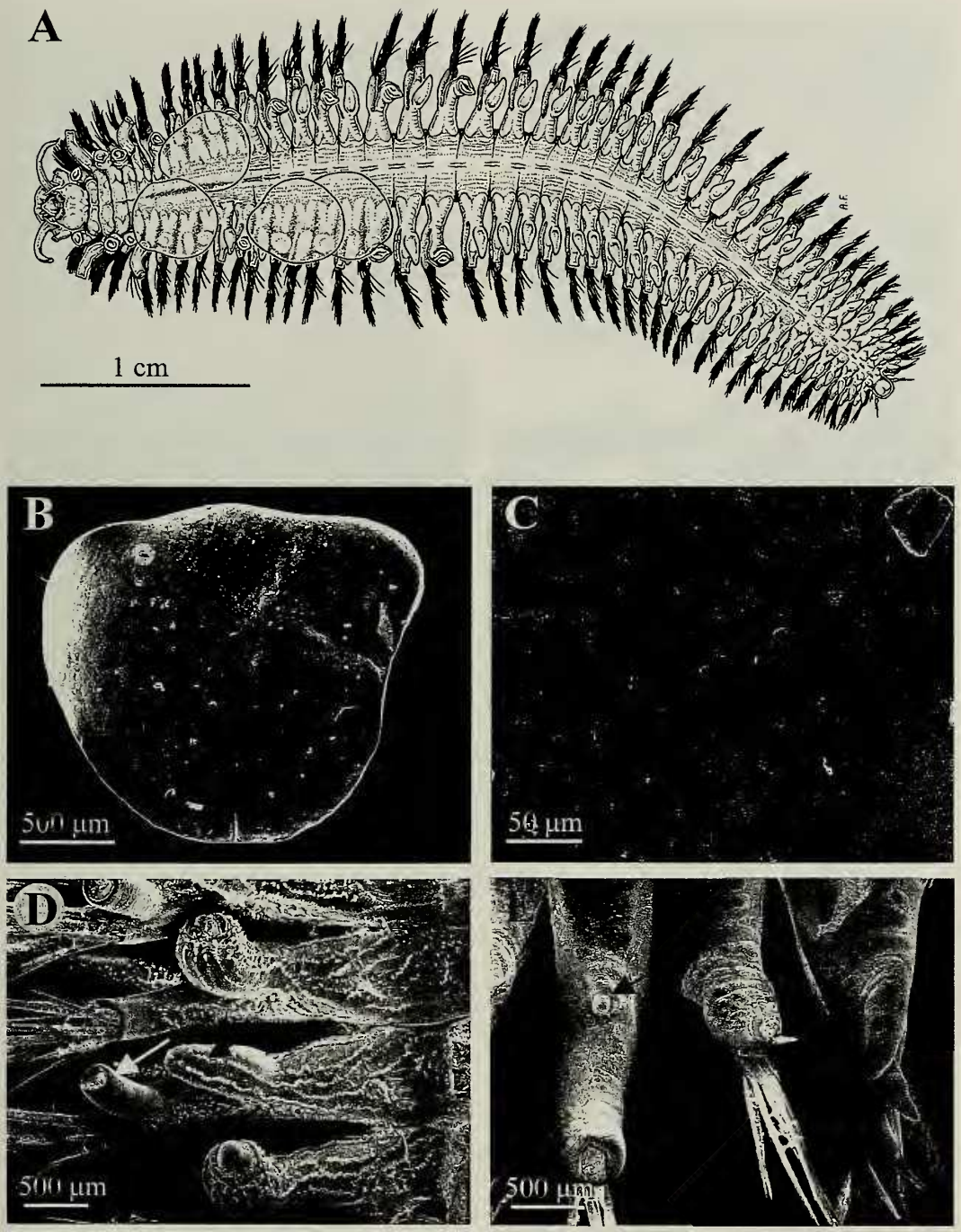

Fig. 1. A. Drawing of paratype (R473-6096), dorsal view of whole specimen. Dorsal cirri have broken off. B–E, SEM views. B. Elytron from the mid-section, dorsal view. C. Detail of elytral surface. D. Dorsal view of segments 11 (bottom) -14 (top). White arrow points to cirrophore on segment 12, black arrow points to digitiform dorsal tubercle on the same segment. E. Detail of first dorsal tubercle on segment 6 (black arrow).

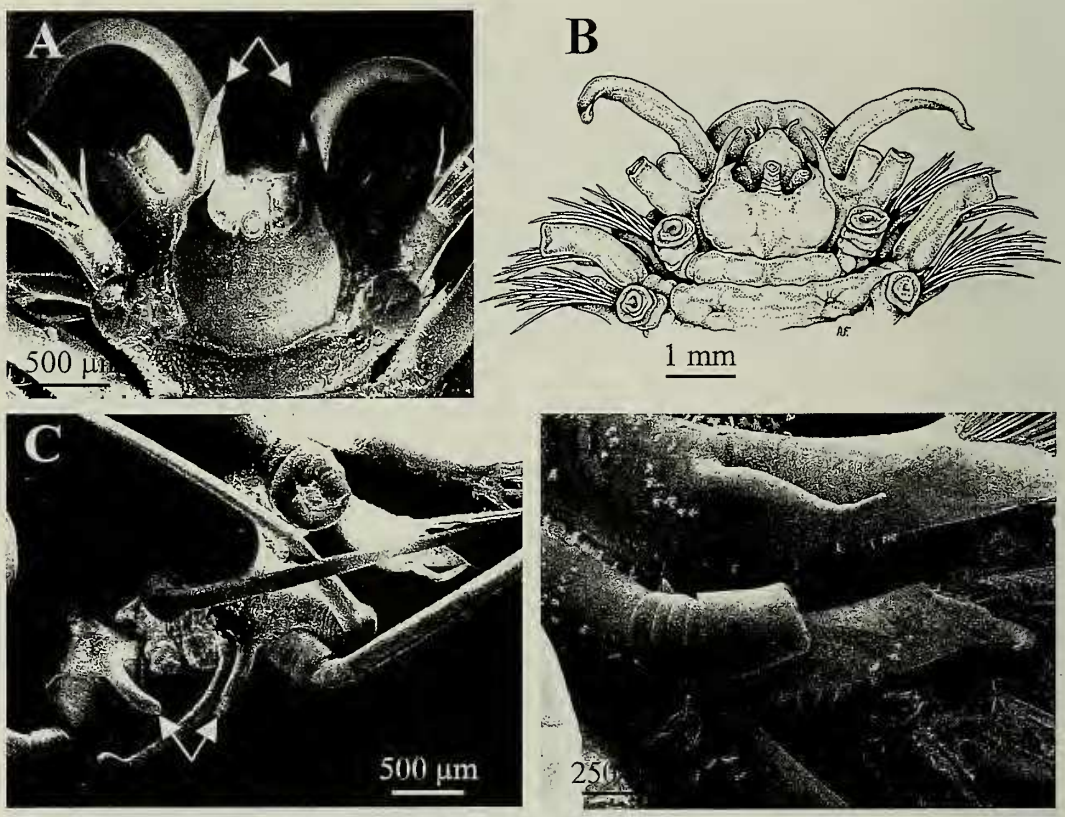

Fig. 2. A, C, and D, SEM views. A. Dorsal view of anterior part of worm. White arrows point to the strong acicular lobes protruding from the 1st segment. Black arrow points to the left hooked frontal filament. B. Drawing of the anterior part of paratype (R473-6096), pharynx partially everted. C. Frontal view of prostomium showing median antenna, tentacular cirri, acicular lobes (white arrows). D. Detail of the buccal cirrophore (black arrow), and second ventral cirrus (3rd segment).

tubercles become dorso-ventrally flattened on the posterior segments of the worm.

Prostomium bilobed, with hooked frontal filaments (Fig. 2A–C). Lateral antennae absent. Median antenna approximately 2–3 times the length of the prostomium; tapers gently to the tip. Median antenna with a short, cylindrical ceratophore inserted in the anterior notch of the prostomium (Fig. 2A–C). Palps approximately twice the length of the prostomium; taper gradually to the tips (Figs. 1A, 2A, B, 3A, B). Eyes lacking. First (or tentacular) segment not visible dorsally. Tentaculophores lateral to the prostomium; each bears one strong brown acicular lobe that curves towards the midline of the body (Figs. 1A, 2A–C, 3A). Tentacular styles long (reaching 0.25 of the body length), slender, tapered. Facial tubercle lacking.

Second (or buccal) segment with first pair of large elytrophores and biramous parapodia (Figs. 1A, 2A–C). Ventral or buccal cirri attached basally on prominent cirrophores lateral to the ventral mouth (Figs. 2D, 3B). Buccal cirri similar in shape to the tentacular cirri; longer than the following ventral cirri. Mouth enclosed in upper, lateral and posterior lips between segments 1 and 3 (Fig. 3A, B). Pharynx never fully everted in the studied specimens. A partially everted pharynx shows papillae at the mouth opening (Fig. 3A). Upper lip with a group of 3 conical curved papillae similar in shape and size. Ventral lip with 3 pairs of conical curved papillae, increas-

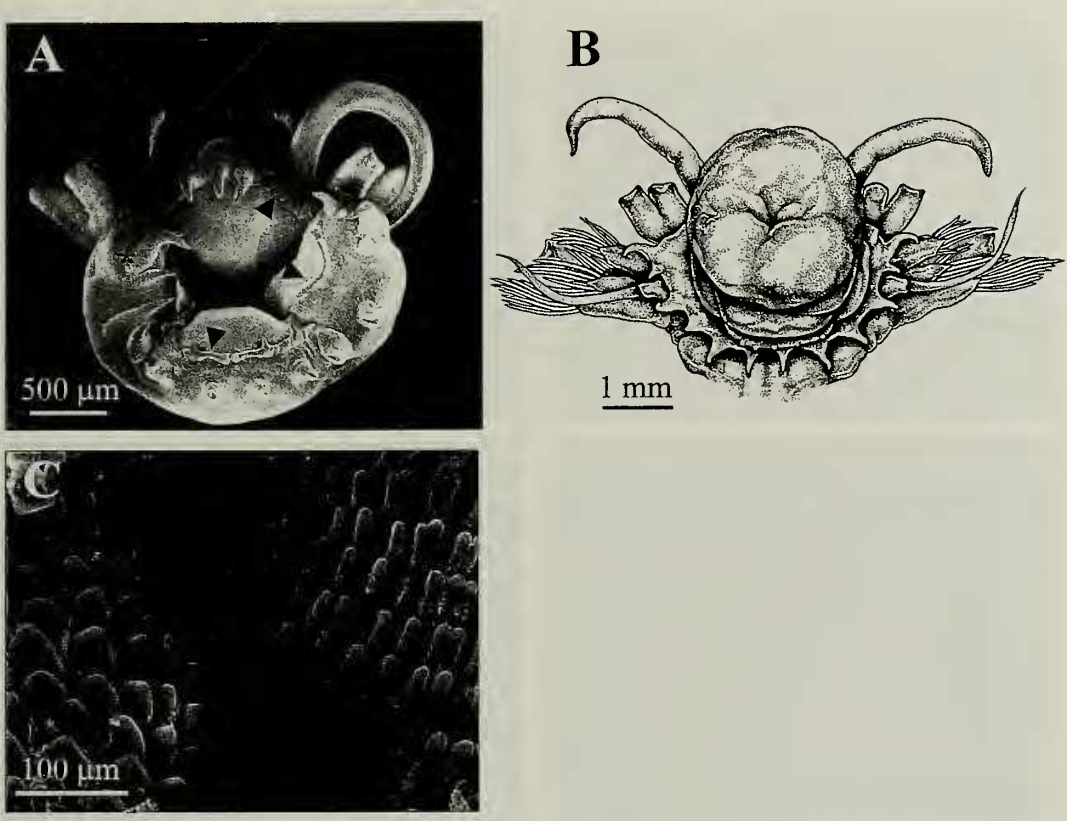

Fig. 3. A and C, SEM views. A. Ventral view of a partially everted pharynx showing upper, lateral and ventral lips with their papillae and ridges. Black arrowheads point to lip ridges, asterisk points to shared bulbous base of the two median papillae on the lateral lip. B. Drawing of paratype (R473-6096), ventral view of a more everted pharynx, with the buccal papillae forming a crown at the base of the pharynx. C. Keratinized teeth at the junction between the mouth opening and the pharynx.

ing in size from the median papilla to the most lateral one. Lateral lips with 4 pairs of conical curved papillae; the central pair shares a bulbous base (Fig. 3A, B). A concentric ridge broken by the limits between the upper, lateral and ventral lips lies interior to the ring of papillae (Fig. 3A). Ridge on the ventral lip divided into two symmetrical parts, each with 3 small, equidistantly placed papillae. Area between the mouth opening and the pharynx bears numerous small (approximately 40 by 50 by 10 µm), keratinized teeth (Fig. 3C). No jaws at the opening of the pharynx.

Parapodia biramous. Notopodia short, on the anterio-dorsal side of the longer neuropodia (Figs. 1D, 4A–F). Elytrigerous notopodia cylindrical (Fig. 4A, B), the posterior lobe forms a ligule (Fig. 4A). On posterior cirrigerous segments, the acicula protrudes from the acicular lobe (Fig. 4E, F). On cirrigerous notopodia, the cirrophore projects at the emergence point of the notosetae (Fig. 4C, D). Upper and lower margins of the neuropodia deeply cleft. Conical presetal lobes of neuropdia equal in length to the rounded postsetal lobes (Fig. 4A–F). Presetal lobe extended by a ligule (Fig. 4B, D, F). Ventral cirri short and tapered; located at the base of the neuropodia (Fig. 4A–F).

Notosetae (approximately 10 per notopodium) stouter than neurosetae (Fig. 4A–F), smooth, and taper to blunt tips (Fig. 5A). Neuropodia with 2 types of setae. Lower neurosetae curved (Figs. 4A–D, 5B);

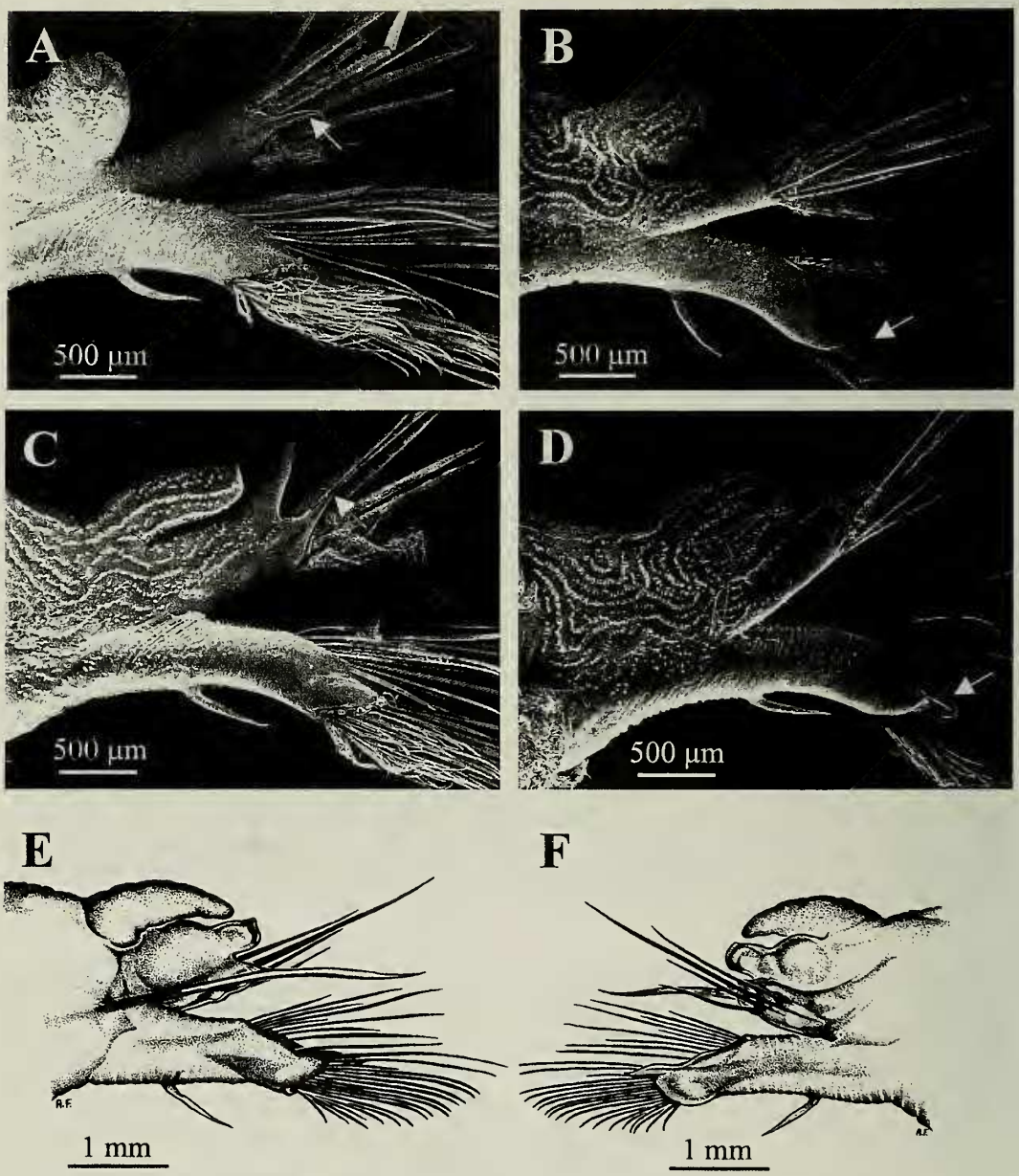

Fig. 4. A–D, SEM views; E and F, drawings. A Posterior view of elytrigerous parapodium (segment 15). Arrow points to the ligule of the notopodium. B. Anterior view of the parapodium from the same segment. Arrow points to the ligule of the neuropodium. C. Posterior view of cirrigerous parapodium (segment 14). Arrow points to the ligule of the notopodium. D. Anterior view of the parapodium from the same segment. Arrow points to the ligule of the neuropodium. E. Posterior view of cirrigerous parapodium of segment 24, note the protruding acicula. F. Anterior view of the same parapodium depicted in E.

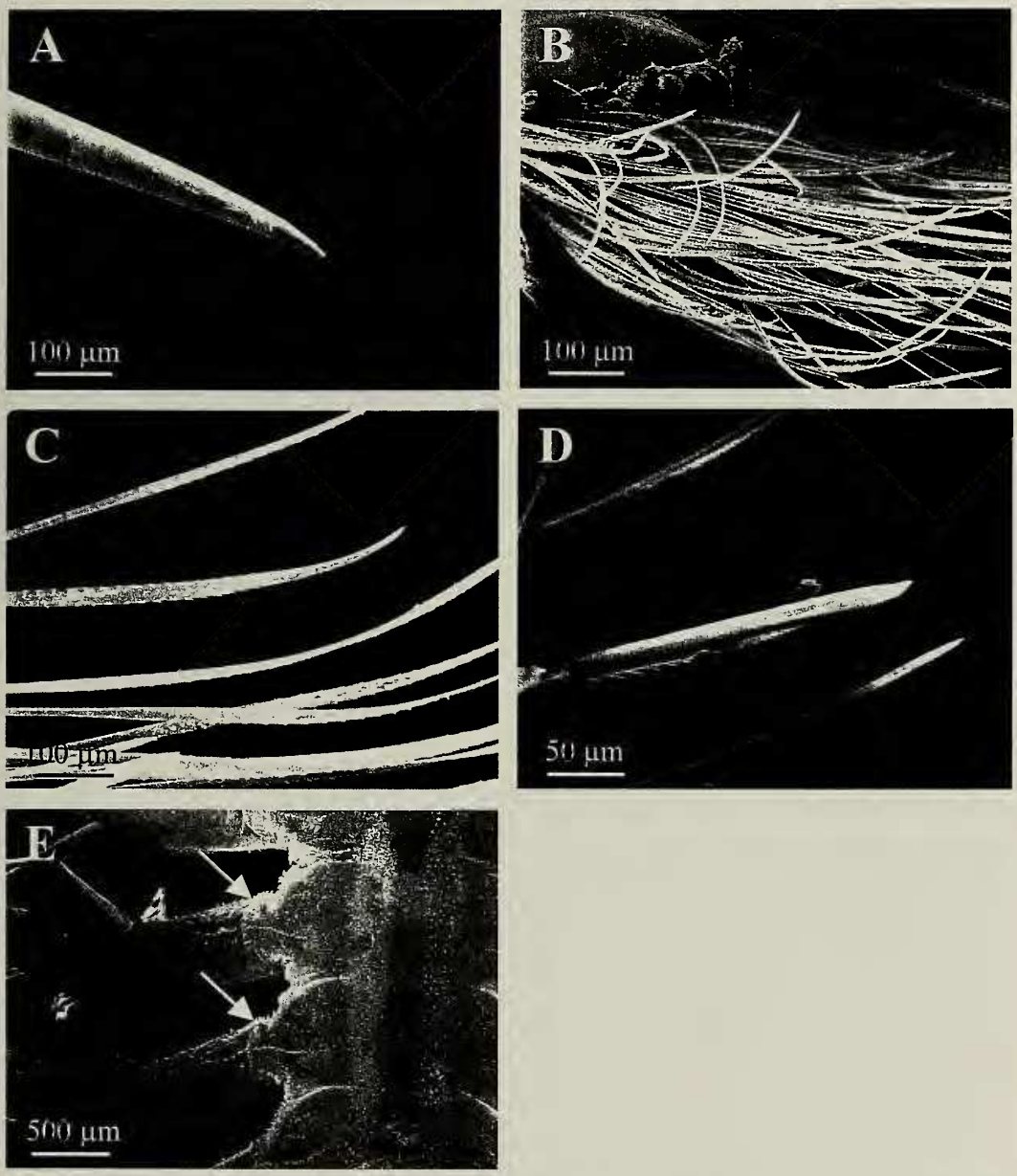

Fig. 5. A–E, SEM views. A. Tip of a notoseta. B. Feather-like neurosetae on the lower side of the neuropodium. C. Upper neurosetae. D. Detail of neurosetae tips. E. Ventral view of segments 11–14 showing inconspicuous nephridial papillae (white arrows).

at a higher magnification setae appear feather-like. Upper neurosetae flattened with lateral teeth (Fig. 5C). Teeth begin just above the emergence point of the setae, and continue to the tapered, curved, scoop-like tip (Fig. 5C, D). Setae similar on all segments.

Nephridial papillae inconspicuous; begin on segment 5 and continue along length of the body (Fig. 5E). Pygidium small, rounded, and with a pair of short anal cirri.

Ecology.—Vampiropolynoe embleyi appears to specialize at colonizing new vents. This suggestion is supported by the absence

of the species from the numerous observations and collections of animals made at sustained venting sites at Axial since the mid-80s, and its presence in high densities at most new vents created by the Axial eruption (10 of 14 vents observed in 1998). The large size of *V. embleyi* and its conspicuous red coloring makes it highly unlikely that it would have been overlooked. Furthermore, *V. embleyi* is easily observed in photographs of CoAxial Segment (Juan de Fuca Ridge) vents one year after their initiation by an eruption, although specimens were not collected (V. Tunnicliffe, pers. comm.).

Vampiropolynoe embleyi lives on vent peripheries, beyond the immediate area of fluid flow. The species is strikingly more active than other vent polynoids: it crawls quickly across the basalt, and swims short distances when disturbed. At most vents in July 1998, *V. embleyi* was observed spaced at least a body length apart from other individuals (of both *V. embleyi* and other vent polynoid species), but at two sites it occurred in relatively dense monospecific patches, reaching densities up to 60 individuals/m^2 (Cloud and Marker 108 vents). Densities decreased by June 1999 (highest was 30 individuals/m^2 at Cloud vent), and by July 2000, two and a half years after vent creation, *V. embleyi* was not evident in bottom observations, although still present in very low numbers (2 specimens found in 32 collections).

These observations strongly suggest that *V. embleyi* is a pioneer species, adapted to living at hydrothermal vents within the first two years after their creation. The feeding structures of *V. embleyi* are consistent with observations of it grazing on bacteria and gelatinous material. Many studies report the correlation between seafloor eruptions and subsequent proliferation of bacterial mats (see Delaney et al. 1999 for review). *V. embleyi* is likely capitalizing on this abundant food source which may last for months to years following an eruptive event.

Discussion

Vampiropolynoe embleyi is a deep-sea species collected from vents created by the eruption on Axial Volcano, Juan de Fuca Ridge. The new subfamily erected here, the Vampiropolynoinae, is closely related to the Macellicephalinae and Lepidonotopodinae. The bilobed prostomium and the lack of lateral antennae typify these two subfamilies. However, the Vampiropolynoinae is clearly distinguished from the Macellicephalinae and Lepidonotopodinae by the absence of jaws, the presence of keratinized teeth, and the presence of a pair of strong hooked acicular lobes on the first segment. The high number of segments of *V. embleyi* (up to 45) also clearly differentiates it from the Lepidonotopodinae (23 to 30 segments; Desbruyères & Hourdez 2000a, b), and the Macellicephalinae (15 to 28 segments; Pettibone 1989, Hourdez & Desbruyères 2000).

The suggestion that *Vampiropolynoe embleyi* is a vent pioneer species adapted to conditions following eruptive events awaits further confirmation from future eruptions on the Juan de Fuca Ridge.

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